T. WALTHAM, F. BELL, AND M. CULSHAW: SINKHOLES AND SUBSIDENCE; KARST AND CAVERNOUS ROCKS IN ENGINEERING AND CONSTRUCTION. SPRINGER (IN ASSOCIATION WITH PRAXIS), 383PP. BERLIN, NEW YORK, CHICHESTER, 2005.

One of the informal conclusions of the 13th International Karstological School, held at Postojna (Slovenia) in June 2005, was that the application of engineering geology approaches to general karst geomorphology has become urgent. Just a short time later, an echo appeared in the arena – in the form of the present book. Perhaps this coincidence is a good indication that such a book was really needed. The names and backgrounds of the authors – among them Tony Waltham, a caver who is known throughout the world – promise a book of high quality.

The contents of this hard-back book, produced in the B5 format, are arranged into 13 chapters, each covering a specific aspect of the central topic. The text begins with a list of contributors, a list of figures (240 in total), a list of tables (20 in total), a list of boxed articles (7 in total), and a glossary. At the end of the book there are references (441 in total), an index of locations and a subject index. The list of all contributors (the 3 main authors plus 20 concerned with details of specific topics), including their E-mail addresses, promises to be very useful. This comprehensive suite of ancillary information says a lot about the very useful arrangement of the book as a whole.

The main text begins with a chapter entitled Rocks, *dissolution and karst.* This is a short but comprehensive summary of the fundamentals of karst science, important to an engineering geologist. Carefully chosen illustrations (photos as well as diagrams) make the topic clear even to readers who are not acquainted in detail with the karst and the engineering problems that it poses. The next chapter, *Sinkhole classification and nomenclature,* even manages to astonish someone who has some experience with collapse phenomena in the karst. The variety of forms and related processes that are considered is truly wide, covering the span between solution sinkholes and subsidence, suffosion and dropout sinkholes. Table (2.1), which is supported by drawings, makes the proposed classification clear. A useful section relates various types of sinkholes to different types of karst, while a "boxed example" introduces a general style feature of the book – the constant mutual inter-relation of general information and topic-specific case studies. The 3rd chapter, entitled *Rock failure in collapse and caprock sinkholes,* deals with perhaps the most attractive, but – as it turns out – generally less important aspect of collapse in the karst. A short, concise introductory section, covering various possible cases and some basic geomechanical views, is followed by a number of field examples, which are well documented by photographs and very enlightening drawings. The authors' interests and coverage also extend to gypsum and salt. It turns out that *Soil failure in subsidence sinkholes,* as covered by the fourth chapter, appear less spectacular, yet (p.85), *"The vast majority of ground failures within karst are due to the erosion, transport and failure of the soils that overlie cavernous bedrock."* The text here is organized in similar fashion to that in other chapters. What is attempted is the exposure of the relationships between surface features and their underground roots, whether in soil or in bedrock. Sections covering the evolution of sinkholes, the spatial distribution of sinkholes and subsidence sinkhole geohazards are a gold mine of ideas and information for a practical geologist. The following (5th) chapter lists various forms of *Buried sinkholes and rockhead features,* including phenomena found in chalk. Chapter 6 covers *Sinkholes in insoluble rocks,* dealing mainly with lava tubes. Various examples from all over the world are so convincing that, though they are less well known, it is clear that related problems should not be overlooked. Again, the presentation of an engineering solution to a practical problem (Portland) makes the book into a kind of manual. *Rock failure under imposed load over caves* (Chapter 7) is a problem that is growing,

as karstified regions of the world become more and more heavily populated. The text covers a theoretical view of the problem, as well as providing practical examples. The following chapter discusses *Sinkholes induced by engineering works.* It becomes apparent that changes in ground water behaviour (introduction of new water, the decline or oscillations of ground water level) trigger off the worst damage.

Having completed discussion of the actual phenomena of sinkholes and related features, in the following chapter the authors consider *Ground investigation in sinkhole terrains,* as the first step in actively dealing with the problems. The spectrum of useful methods presented is really large. Tables 9.2 and 9.3 present a concise survey of the methods available and the circumstances in which they should be used. The 3-D simulations that are provided will prove interesting even to less practically oriented karstologists. The 10th chapter, entitled *Hazard and risk assessment of sinkholes* continues the logical extension of the text. Flow charts, case studies and various tables offer a rich source of suggestions for the field geologist. Sections covering *Legislation…* and *… insurance* discuss topics that are too often overlooked, but which may greatly influence the course of investigation and remediation. The main part of the book culminates in chapters 11 *(Prevention and remediation of sinkholes)* and 12 *(Construction in sinkhole terrains).* A selection of practical guidelines, encompassing the most important situations and based on practical examples provide a source of inspiration for any civil engineer faced with sinkhole problems during constructional and remedial works in the karst. Finally, Chapter 13 presents a collection of sixteen carefully chosen case studies, each section written by authors who have directly faced the individual problems.

Whereas the book discusses very diverse topics, while still managing to cover the central problem, it remains systematic and, above all, lucid. The figures have been carefully chosen and matched, and even those taken from existing literature have been redrawn to the same common (high) standard. Photographs are of high quality, and related directly to the text. Numerous practical examples are elaborated in Boxes, and usually supported by figures. Some readers might wish for a deeper theoretical analysis of the geomechanical background of various sinkhole-related events, but to the present reviewer this possible lack is not a weak point. Instead it provides a warning that the gap between theory and practical experience (in fact, insufficient knowledge of controlling parameters) is still large.

Problems with sinkholes and related types of hole are widely known and are being wrestled with in many parts of the world. Nevertheless, before the present book the related data have never been put together in such a systematic way. It is, and it will remain, the essential work in this specific field of applied karstology. It is difficult to imagine that anyone will produce something more exhaustive and better founded in the foreseeable future.

From the viewpoint of more general karstology, this book has also cleared up many a partial question concerning this specific kind of karst dynamics. As mentioned above, it emerges that the main problem in the karst is not spectacular collapse phenomena in bedrock, but various failures of a soil mantle upon the rocky basement. Consequently, the problem does not originate in basically karstic processes, but in specific relationships that originate at the interface between the karst (in a narrow sense) and non-karstic cover. Thus, the dynamic is less related to speleogenesis (or decay), and more to the karst surface phenomena. Additionally, the extent of collapse features in non-carbonate karstic rocks has become well related to carbonate karst features. And – finally – the plea of the 13th International Karstological School has been resolved in the best way. It is now in the hands of karst geomorphologists to pick up what has been offered to them and then to apply it. One might expect that this will become one of the most cited books in the karstological literature in the near future.

For a Slovene karstologist the book is of special interest, as it covers a number of cases in Slovenia. It becomes clear, that though perhaps among the most spectacular – except for the Chinese ones, which dwarf anything else – collapse phenomena in the Slovene karst do not pose serious problems. In Chapter 13 a section, written by Slovene authors, is dedicated to the experience acquired during motorway construction in Slovenia. The importance of the contribution is manifold. Besides its promotion of the Classical Karst, it provides a good overview of the technical problems encountered during building works, as well as yielding an insight into the interface between the surface and the endokarst in the region that gave its name to these natural phenomena.

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